

TEST REPORT FROM RFI GLOBAL SERVICES LTD

Partial Test of: Raymarine Ltd.
S1000 Autopilot.

To: FCC Part 15.247

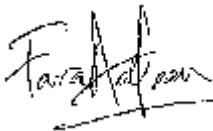
Test Report Serial No:
RFI/MPTE2/RP46813JD10A
Supersedes Test Report Serial No:
RFI/MPTE1/RP46813JD10A

This Test Report Is Issued Under The Authority
Of Andrew Brown, Operations Manager:

A handwritten signature in black ink, appearing to read 'Andrew Brown', written over a white background.

pp

Tested By: Fara Razally

A handwritten signature in black ink, appearing to read 'Fara Razally', written over a white background.

Checked By: Nigel Davison

A handwritten signature in black ink, appearing to read 'Nigel Davison', written over a white background.

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Issue Date: 26 January 2005

Test Dates: 05 January 2005

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1. Client Information

Company Name:	Raymarine Ltd
Address:	Robinson Way Anchorage Park Portsmouth Hampshire PO3 5TD United Kingdom
Contact Name:	Mr Christopher Bird

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2. Equipment Under Test (EUT)

The following information (with the exception of the Date of Receipt) has been supplied by the client:

2.1. Identification of Equipment Under Test (EUT)

Brand Name:	Raymarine
Model Name or Number:	S1000 Autopilot
Unique Type Identification:	A18107
Serial Number:	D5
FCC ID Number:	PJ5S1000
Country of Manufacture:	UK
Date of Receipt:	04 January 2005

2.2. Description of EUT

The equipment under test is a Gateway used in conjunction with the S100 Controller. It functions as a wirelessly controlled Autopilot.

2.3. Modifications Incorporated in EUT

During the course of testing the EUT was not modified.

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2.4. Additional Information Related to Testing

Power Supply Requirement:	DC supply of 12 V DC external supply		
Intended Operating Environment:	Maritime		
Equipment Category:	Short Range (Low Power)		
Type of Unit:	Mobile (Vehicular Use, powered via vehicle regulated supply) Maritime		
Interface Ports:	Enclosure Antenna Port		
Transmit Frequency Range:	2405 MHz to 2480 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	0	2405
	Middle	7	2440
	Top	15	2480
Receive Frequency Range:	2405 MHz to 2480 MHz		
Receive Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	0	2405
	Middle	7	2440
	Top	15	2480
Maximum Power Output (EIRP)	5.3 dBm		

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2.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Laptop
Brand Name:	Toshiba
Model Name or Number:	PA5401EA
Serial Number:	19018855
Cable Length and Type:	RS232, 1 meter
Connected to Port:	Communication

Description:	Communication Interface Board
Brand Name:	None Stated
Model Name or Number:	None Stated
Serial Number:	None Stated
Cable Length and Type:	9 Pin Circular to RS232
Connected to Port:	Communication

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3. Test Results

Reference:	FCC Part 15 Subpart C: 2003 (Section 15.247)
Title:	Code of Federal Regulations, Part 15 (47CFR15) Radio Frequency Devices
Purpose of Test:	To determine whether the equipment complied with the requirements of the specification for the purposes of certification.

3.1. Methods and Procedures

The methods and procedures used were as detailed in:

ANSI C63.2 (1987)

Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (2003)

Title: American National Standard Methods of Measurement of Electromagnetic Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1988)

Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)

Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1: (1999)

Title: Specification For Radio Disturbance and Immunity Measuring Apparatus and Methods. Part 1: Radio Disturbance and Immunity Measuring Apparatus.

DA00-705 (2000)

Title: Filing and Frequency Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

3.2. Definition of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the Methods & Procedures section above. Appendix 1 contains a list of the test equipment used.

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4. Deviations from the Test Specification

No emissions testing were performed at the request of the client.

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5. Operation of the EUT During Testing

5.1. Operating Conditions

The EUT was tested in a normal laboratory environment.

During testing, the EUT was powered by 12 V DC external supply.

5.2. Operating Modes

The EUT was tested in the following operating modes, unless otherwise stated.

The EUT was transmitting continuously with modulation, Pseudo random data. Final measurements were performed on bottom, middle and top channel.

5.3. Configuration and Peripherals

The EUT was tested in the following configuration:

EUT was connected to an external 12 V DC supply and connected to the laptop PC via a 9 Pin circular connector interface, which is hard wired to the EUT.

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6. Summary of Test Results

Range of Measurements	Specification Reference	Port Type	Compliance Status
Transmitter Minimum 6 dB Bandwidth	C.F.R. 47 FCC Part 15: 2003 Section 15.247(a)(2)	Antenna Terminals	Complied
Transmitter 20 dB Bandwidth*	C.F.R. 47 FCC Part 2: 2003 Section 2.1049	Antenna Terminals	Complied
Transmitter Peak Power Spectral Density	C.F.R. 47 FCC Part 15: 2003 Section 15.247(e)	Antenna Terminals	Complied
Transmitter Maximum Peak Output Power	C.F.R. 47 FCC Part 15: 2003 Section 15.247(b)(3)	Antenna Terminals	Complied

**Industry Canada Requirement.*

6.1. Location of Tests

All the measurements described in this report were performed at the premises of
RFI Global Services Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ, England.

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7. Measurements, Examinations and Derived Results

7.1. General Comments

7.1.1. This section contains test results only.

7.1.2. Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 8 for details of measurement uncertainties.

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7.2.Transmitter Minimum 6 dB Bandwidth: Section 15.247(a)(2)

7.2.1. The EUT was configured as for transmitter minimum bandwidth measurements as described in Section 9 of this report.

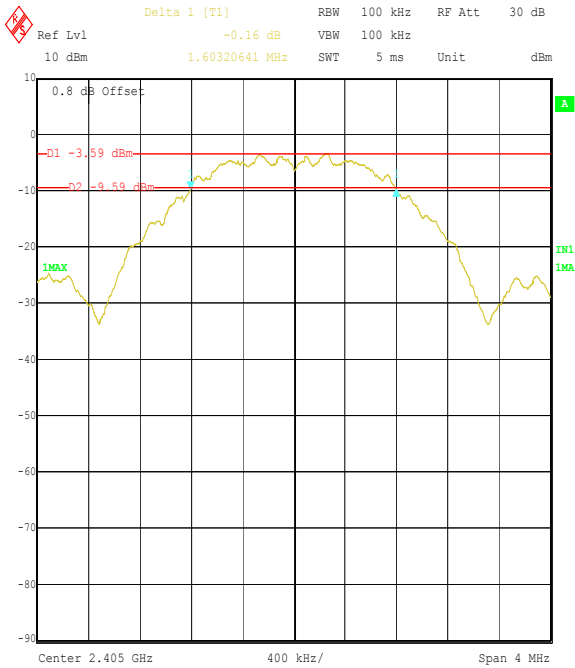
7.2.2. Tests were performed to identify the 6 dB bandwidth of the fundamental signal.

Results:

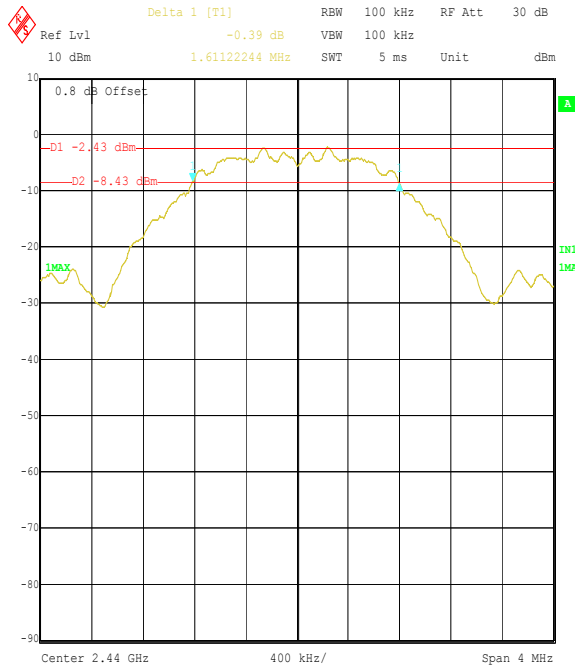
Channel	Transmitter 6 dB Bandwidth (MHz)	Limit (MHz)	Margin (MHz)	Result
Bottom	1.603	≥ 0.5	1.103	Complied
Middle	1.611	≥ 0.5	1.111	Complied
Top	1.479	≥ 0.5	1.979	Complied

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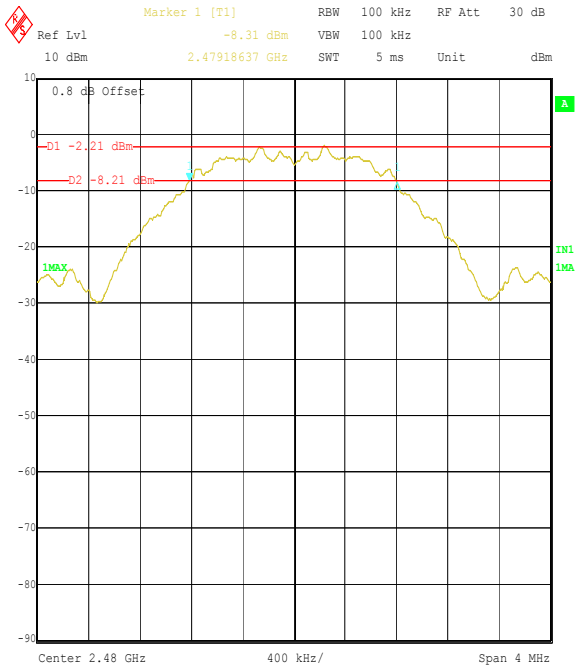
Transmitter Minimum 6 dB Bandwidth: Section 15.247(a)(2) (Continued)



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: 6 dB Bandwidth Bottom Channel
Date: 4.JAN.2005 13:41:35



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: 6 dB Bandwidth Middle Channel
Date: 4.JAN.2005 13:38:01



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: 6 dB Bandwidth Top Channel
Date: 4.JAN.2005 13:40:12

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7.3.Transmitter 20 dB Bandwidth: Section 2.1049

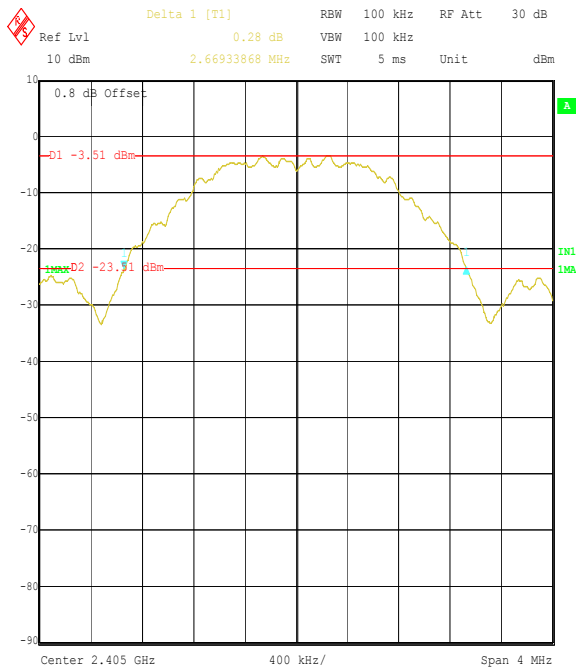
7.3.1. The EUT was configured as for 20 dB bandwidth measurements as described in Section 9 of this report.

7.3.2. Tests were performed to identify the 20 dB bandwidth.

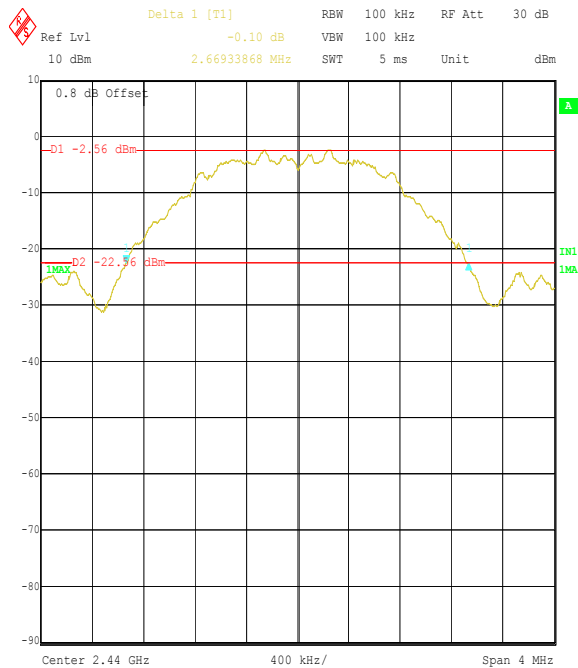
Channel	Transmitter 20 dB Bandwidth (kHz)
Bottom	2669.33868
Middle	2669.33868
Top	2661.32265

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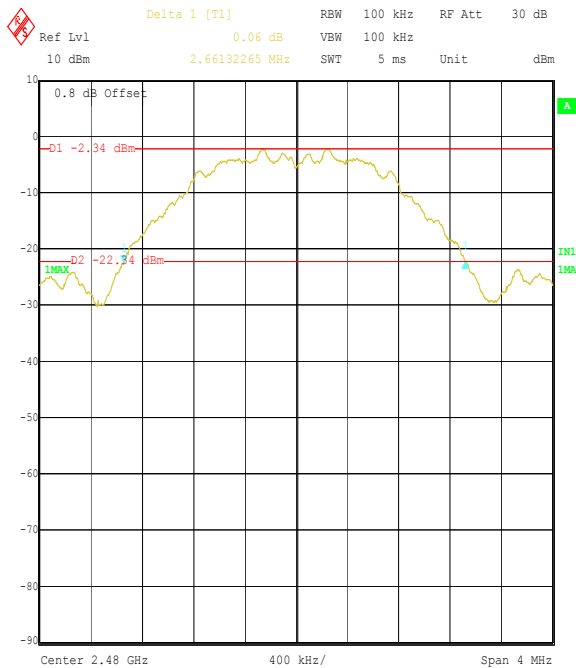
Transmitter 20 dB Bandwidth: Section 2.1049 (Continued)



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: 20 dB Bandwidth Bottom Channel
Date: 4.JAN.2005 13:43:41



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: 20 dB Bandwidth Middle Channel
Date: 4.JAN.2005 13:45:04



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: 20 dB Bandwidth Top Channel
Date: 4.JAN.2005 13:46:27

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7.4.Transmitter Peak Power Spectral Density: Section 15.247(e)

7.4.1. The EUT was configured as for transmitter peak power spectral density measurements as described in Section 9 of this report.

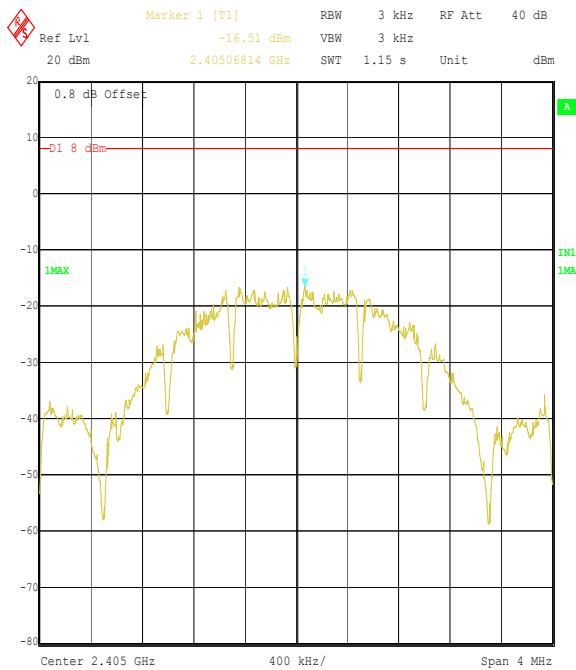
7.4.2. Tests were performed to identify the maximum peak power spectral density of the Fundamental.

Results:

Channel	Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-16.5	8	24.5	Complied
Middle	-14.6	8	22.6	Complied
Top	-14.4	8	22.4	Complied

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Transmitter Peak Power Spectral Density: Section 15.247(d) (Continued)



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: Peak Power Spectral Density Bottom Channel
Date: 4.JAN.2005 13:55:47



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: Peak Power Spectral Density Middle Channel
Date: 4.JAN.2005 13:53:21



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: Peak Power Spectral Density Top Channel
Date: 4.JAN.2005 13:54:34

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7.5. Transmitter Maximum Peak Output Power: Section 15.247(b)(3)

7.5.1. The EUT was configured as for transmitter peak output power measurements as described in Section 9 of this report.

7.5.2. Tests were performed to identify the transmitter maximum peak output power (EIRP) of the EUT.

7.5.3. The effective isotropic radiated power (EIRP) was calculated by adding the manufacturer's declared antenna gain to the figure measured for conducted RF output power.

Results:

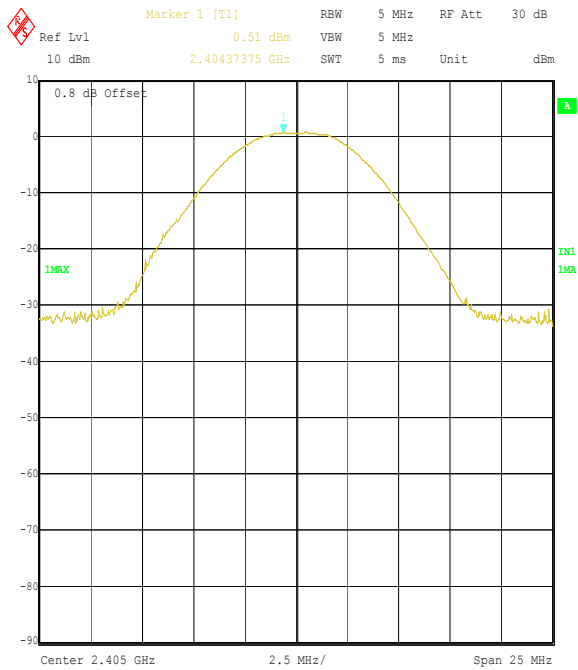
Battery Powered Devices

Channel	Conducted RF O/P Power (dBm)	Stated Antenna Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	0.5	4.1	4.6	30.0	25.4	Complied
Middle	1.0	4.1	5.1	30.0	24.9	Complied
Top	1.2	4.1	5.3	30.0	24.7	Complied

NOTE: As per the requirements of Public Notice DA 00-705, the stated antenna gain of the EUT is 4.1 dBi which, when added to the highest (worst case) measured conducted peak output power of 1.2 dBm (from the table above) gives a de facto EIRP of 5.3 dBm. This is in compliance with the requirements of Section 15.247(b)(3) for de facto EIRP limitation i.e. 1 Watt (30 dBm).

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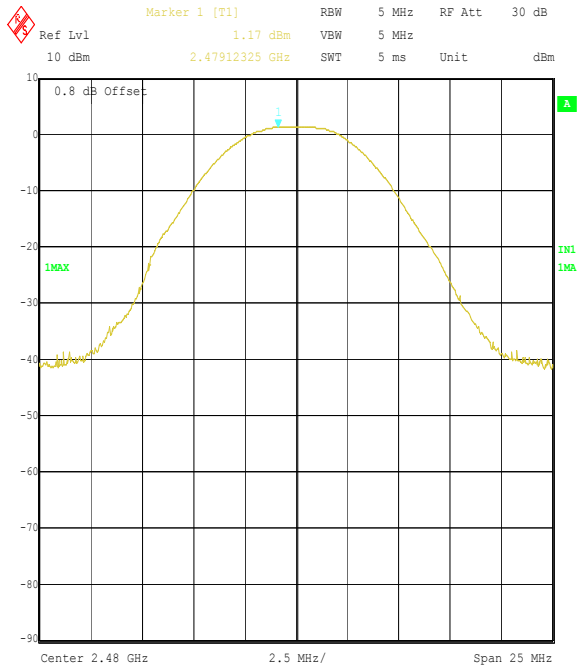
Transmitter Maximum Peak Output Power: Section 15.247(b)(3) (Continued)



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: Peak Output Power Bottom Channel
Date: 4.JAN.2005 13:58:29



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: Peak Output Power Middle Channel
Date: 4.JAN.2005 13:59:23



Title: Raymarine 46813JD10 EUT S1000 Autopilot FCC P15.247
Comment A: Peak Output Power Top Channel
Date: 4.JAN.2005 14:00:01

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8. Measurement Uncertainty

8.1. No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

8.2. The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

8.3. The uncertainty of the result may need to be taken into account when interpreting the measurement results.

8.4. The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Transmitter Maximum Peak Output Power	Not applicable	95%	+/- 0.46 dB
Spectral Power Density	Not applicable	95%	+/- 1.2 dB
6 dB/20 dB Bandwidth	Not applicable	95%	+/- 0.12 %

8.5. The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

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9. Measurement Methods

9.1. Minimum 6 dB Bandwidth

The EUT and spectrum analyser were configured as for conducted antenna port emissions measurements.

Prior to testing being performed a suitable RF attenuator and cable were calibrated for the required frequencies. For each frequency the calibrated level of the attenuator and cable were entered as an offset into the spectrum analyser to compensate for the losses in the measurement set up.

To determine the 6 dB bandwidth, a resolution bandwidth of 100 kHz was used, which is approximates to 1% of the 6 dB bandwidth. A video bandwidth of 300 kHz was used. The analyser was set to a span of greater than twice the 6 dB bandwidth and for a maximum hold scan to capture the profile of the signal. The peak level was then determined, and a reference established 6 dB below the peak level. The bandwidth was determined at the points where the 6 dB reference crossed the profile of the emission.

The EUT was connected to a spectrum analyser enabled with an occupied bandwidth function via a suitable RF attenuator and cable calibrated for the required frequency range. The calibrated level of the attenuator and cable were entered as an offset into the spectrum analyser to compensate for the losses in the measurement set up.

The 6 dB Bandwidth was measured using the built in occupied bandwidth function of the Rohde and Schwarz FSEB or ESIB spectrum analyser. It was set to measure the bandwidth where 75% (6 dB) of the signal power was contained. The analyser settings were set as per those outlined in the spectrum analyser user manual for this measurement, i.e. RBW $\geq$ 1% of occupied bandwidth. A value of 100 kHz was used.

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9.2. Transmitter 20 dB Bandwidth

The EUT and spectrum analyser was configured as for transmitter radiated emissions measurements.

To determine the occupied bandwidth, a resolution bandwidth of 100 kHz was used, which is greater than 1% of the 20 dB bandwidth. A video bandwidth of at least the same value was used. The analyser was set for a maximum hold scan to capture the profile of the signal. The peak level was then determined, and a reference line was drawn 20 dB below the peak level. The bandwidth was determined at the points where the 20 dB reference crossed the profile of the emission.

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9.3. Spectral Power Density

The EUT and spectrum analyser were configured as for conducted antenna port emissions measurements.

Prior to testing being performed a suitable RF attenuator and cable were calibrated for the required frequencies. For each frequency the calibrated level of the attenuator and cable were entered as an offset into the spectrum analyser to compensate for the losses in the measurement set up.

Prior to the measurement being taken the spectrum analyser was tuned to the fundamental frequency of the EUT.

A resolution bandwidth of 3 kHz was selected and the analyser was set to a span of greater than twice the 6 dB bandwidth. The trace was max held and a reading was taken at the peak point of the trace.

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9.4. Peak Output Power

The EUT and spectrum analyser were configured as for conducted antenna port measurements and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

Prior to testing being performed a suitable RF attenuator and cable were calibrated for the required frequencies. For each frequency to be measured, the calibrated level of the attenuator and cable were entered as an offset into a spectrum analyser to compensate for the measurement set up.

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Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.
A1256	Power supply	Farnell	11E30/1B	000378
M028	FSB Spectrum Analyser	Rohde & Schwarz	FSB	860 001/009 (RF), 860 161/007 (Display)
M058	Multimeter	Fluke	79	54940691
M1124	ESIB26	Rohde & Schwarz	ESIB26	100046K
M1132	Thermo Hygro	RS	212-124	05A03

NB In accordance with UKAS requirements, all the measurement equipment is on a calibration schedule.